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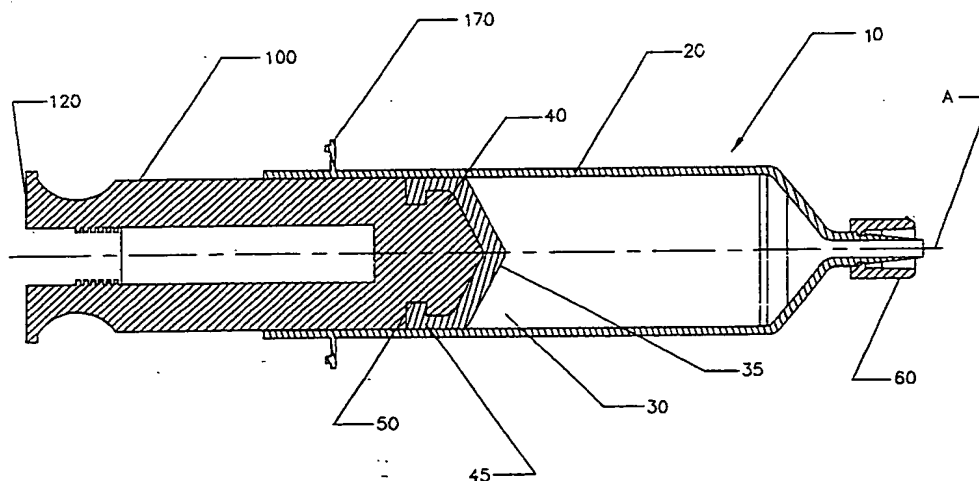
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(54) Title: **SYRINGE, INJECTOR AND INJECTOR SYSTEM**

## (57) Abstract

The present invention provides a syringe and a powered injector for use therewith in which the syringe is attachable to a powered drive member of an injector over a range of relative axial positions of the syringe plunger and the drive member. The syringe comprises a plunger, and a plunger extension connected thereto and extending rearward from the plunger, such that the syringe may be operated manually or by a powered injector. By providing a plurality of cooperating attachment members over a range of axial positions on at least one of the plunger extension or the powered drive member, operative attachment of the plunger and the drive member is made possible at multiple axial positions of the plunger (within the syringe) for each axial position of the drive member over at least a range of possible plunger axial positions. Attachment of the plunger to the drive member at various axial positions of the plunger thus becomes an easier task than previously possible with current powered injector systems.

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## TITLE

### SYRINGE, INJECTOR AND INJECTOR SYSTEM

#### Field of the Invention

The present invention relates to a syringe, an injector and an injector  
5 system, and particularly to a syringe, an injector and an injector system in which the  
syringe plunger is attachable to a drive member of the injector over a range of relative  
axial positions.

#### Background of the Invention

Syringe injection systems have been in use in medical procedures for many  
10 years. Many such syringes are operated manually by advancing a plunger extension in  
operative connection with an internal plunger to pressurize the fluid within the syringe. In  
numerous medical injection procedures, however, accurate control and/or high pressures are  
required that cannot be achieved via manual syringe operation. A number of syringes and  
powered injectors for use therewith have, therefore, been developed for use in medical  
15 procedures such as angiography, computer tomography and NMR/MRI. For example, U.S.  
Patent No. 5,383,858 discloses a front-loading syringe and powered injector in both pressure  
jacket and jacketless embodiments.

Like syringes operated manually, syringes for use with powered injectors  
comprise a plunger for forcing the fluid injection medium from the syringe to be injected into  
20 the patient. These plungers generally include a cooperating attachment member to enable  
attachment of the plunger to a powered drive member in the injector. In all cases, there is only  
one axial position of the injector drive member corresponding to a specific axial position of the

plunger at which attachment of the drive member to the plunger is possible. Typically, the plunger must be placed in a single predetermined axial position within the syringe to enable attachment of the plunger to the injector drive member. Often, the predetermined axial position of the plunger is the rearwardmost position.

5           Such designs present a number of problems. For example, the attachment of the plunger to the drive member is often mechanically difficult for the user, requiring an accurate one-to-one axial alignment. Furthermore, it is preferable to be able to attach the plunger to the drive member when the plunger is not at its rearwardmost position. Attachment of the plunger to the drive member at a somewhat forward position of the plunger, for  
10   example, enables the user to draw the plunger back to check for air in the system or to check for blood in the system to ensure proper insertion of an injection needle.

A number of medical procedures also require that the injection media undergo some preparation before powered injection. In some procedures, for example, a contrast medium is received by the end user in the form of a dry powder that must be mixed with a  
15   liquid vehicle before injection. In general, the amount of liquid added to a specified amount of dry powder must be relatively precisely measured. Typically, a hand-held or manually operated syringe is used to draw the prescribed amount of liquid out of a container. This amount of liquid is then injected into a vial containing the specified amount of the powder. The liquid and powder are then mixed or agitated before injection into a patient.

20           For a number of reasons, it is very difficult to inject such a prepared injection medium using current powered injectors. For example, most manually operated syringes, which are typically used to draw the prepared injection medium, cannot be mounted on current

powered injectors. Moreover, it is difficult to transfer the medium from a manual syringe into a syringe suitable to be mounted on currently available power injectors. Although a small number of syringes and injectors for use therewith have been developed in which the syringe can be used in a manual mode and in a powered injection mode, for example the  
5 syringe/injector system described in WO 82/1988 entitled "Mechanism For Screw Drive And Syringe Plunger Engagement/Disengagement", such syringe/injector systems suffer from the same axial alignment problems discussed above. Further, these prior art syringe/injector systems require the manual alignment of the injector drive mechanism with the syringe plunger.

It is, therefore, desirable to develop a syringe and a powered injector for use  
10 therewith which minimize or eliminate the alignment difficulties discussed above. It is also desirable to develop such a syringe and injector in which the syringe can be operated in a manual mode and in a powered injection mode.

### Summary of the Invention

15 Accordingly, the present invention provides a syringe and a powered injector for use therewith in which the syringe is attachable to a powered drive member of an injector over a range of relative axial positions of the syringe plunger and the drive member. The syringe comprises an elongated body and a plunger movably mounted in the elongated body to pressurize a fluid medium to be injected. The syringe also comprises a  
20 plunger extension connected to the plunger and extending rearward from the plunger. In one embodiment, the plunger extension comprises a plurality of plunger attachment members located over a range of axial positions on the plunger extension. Each of the

plurality of plunger attachment members is adapted to form a releasable attachment with at least one cooperating injector attachment member on the powered drive member. In another embodiment, the plunger extension of the plunger comprises at least one plunger attachment member which is adapted to form a releasable attachment with each of a plurality of corresponding injector attachment members located over a range of axial positions on the powered drive member. By providing a plurality of cooperating attachment members over a range of axial positions on at least one of the plunger extension or the powered drive member, operative attachment of the plunger and the drive member is made possible at multiple axial positions of the plunger (within the syringe) for each axial position of the drive member over at least a range of possible plunger axial positions. Attachment of the plunger to the drive member at various axial positions of the plunger thus becomes an easier task than previously possible with current powered injector systems.

In another embodiment, the plunger extension preferably comprises a plurality of plunger attachment members located over a range of axial positions on the plunger extension. Each of the plurality of plunger attachment members preferably is adapted to form a releasable attachment with each of a plurality of cooperating injector attachment members located over a range of axial positions on the powered drive member. As with the above-described embodiments, operative attachment of the plunger and the drive member is possible at multiple axial positions of the plunger for each axial position of the drive member over at least a range of possible plunger axial positions. Moreover, providing a plurality of cooperating attachment members on each of the plunger extension



and the powered drive member enables cooperating attachment of more than one of the attachment members of the plunger extension with more than one of the attachment members of the powered drive member over a range of relative axial positions of the plunger and the drive member. Such multiple cooperating attachment points provides a stronger connection than provided by a single attachment point and enables use of a wider range of construction materials for the plunger extension and/or the powered drive member. For example, the plunger extension may be fabricated from a disposable plastic material.

Preferably, the attachment members on the plunger extension and the drive member are positioned substantially symmetrically about a common axis to reduce or eliminate uneven loading and torque.

Preferably, the plunger extension is adapted to enable operation of the syringe in a manual mode as well as a powered injection mode. In that regard, the plunger extension preferably extends beyond the rear of the elongated body of the syringe and preferably comprises a flange or pressure member on a rearward end thereof to facilitate manual operation.

#### **Brief Description of the Drawings**

Figure 1 illustrates in cross-section an embodiment of a syringe of the present invention.

Figure 2A illustrates an elevation of an embodiment of a plunger base and plunger extension of the present invention.

Figure 2B illustrates an exploded view of a portion of the plunger base and plunger extension of Figure 2A comprising cooperating attachment members for releasably connecting to a drive member.

Figure 2C illustrates a top perspective view of the embodiment of the  
5 plunger base and plunger extension of Figure 2A.

Figure 2D illustrates a bottom perspective view of the embodiment of the plunger base and plunger extension of Figure 2A.

Figure 3A illustrates a perspective view an embodiment of the powered injector of the present invention.

10 Figure 3B illustrate a perspective view of the powered injector of Figure 3A with the syringe mounted thereon.

Figure 3C illustrates a cross-sectional view of the powered injector of Figure 3A.

Figure 3D illustrates a cross-sectional view of the powered injector of  
15 Figure 3A connected to the syringe of Figure 1.

Figure 3E illustrates a rear perspective view of an embodiment of a retainer in which a syringe has been partially mounted.

Figure 3F illustrates a rear perspective view of the retainer of Figure 3E in which the syringe has been rotated 90 degrees for secure mounting.

20 Figure 4A illustrates proper alignment of an embodiment of a plunger extension and an embodiment of a drive member to effect a releasable connection therebetween.

Figure 4B illustrates insertion of the drive member within a passage in the plunger extension.

Figure 4C illustrates rotation of the plunger extension of Figure 4B relative to the drive member to releasably connect the plunger extension to the drive member.

5 Figure 4D illustrates an exploded view of the drive member.

Figure 4E illustrates a front view of the drive member.

Figure 5 illustrates a cross-sectional view of a syringe taken along line 5-5 of Figure 4A.

10 Figure 6 illustrates a perspective view of another embodiment of a plunger extension and drive member.

### **Detailed Description of the Invention**

As illustrated in Figure 1, syringe 10 comprises an elongated and preferably cylindrical body 20. A plunger 30 is slidably disposed inside cylindrical body 20. Preferably, plunger 30 comprises an elastomeric plunger surface or sealing cover 35 and a base 40. 15 Base 40 is best illustrated in Figures 1, 2A, 2C and 2D and is preferably fabricated from a relatively structurally strong material such as a polypropylene, nylon or polycarbonate.

Contact surface 35 fits over and is supported by base 40. As best illustrated in Figure 1, contact surface 35 may comprise an inwardly projecting circumferential attachment member 45. Attachment member 45 is designed to seat in a channel 50 of base 40 to hold 20 contact surface 35 on base 40. When supported by base 40 and positioned within elongated body 20, the side perimeter of contact surface 35 forms a cylindrical sealing engagement with the inner sidewall of elongated body 20. When drawn rearward, plunger 30 causes fluids to be

drawn into elongated cylindrical body 20. When forced forward, plunger 30 causes any fluid within elongated cylindrical body 20 to be forced out of elongated cylindrical body 20 via syringe tip 60.

As used herein to describe syringe 10, the terms "axial" or "axially" refer generally to an axis A around which syringe 10 is preferably formed (although not necessarily symmetrically therearound). The term "radial" refers generally to a direction normal to axis A. The terms "rear" or "rearward" refer generally to an axial direction away from syringe tip 60. The terms "front" or "forward" refer generally to an axial direction toward syringe tip 60.

Syringe 10 also comprises a plunger extension 100 which is operatively connected to plunger 30 and preferably extends rearward from plunger 30 beyond the rear of elongated cylindrical body 20. In the embodiment illustrated in Figures 2A through 2D, plunger extension 100 is formed integrally with plunger base 40. Plunger extension 100 may be fabricated, however, to be permanently attached or releasably attachable to base 40.

Syringe 10 is preferably designed to be front-loading onto corresponding injector 200. A front-loading syringe and injector system is disclosed in U.S. Patent No. 5,383,858, the disclosure of which is incorporated herein by reference. The present invention is equally applicable, however, to syringe and injector systems other than front-loading syringe and injector systems.

As shown in Fig. 3C, injector housing 235 encloses a reciprocating drive member 210 which cooperates with syringe plunger extension 100 and, thereby, plunger 30 to inject an injection fluid from the interior of elongated cylindrical body 20 into a patient. Drive member 210 is extendible and retractable via a powered means preferably contained within

injection housing 235 and comprising, for example, a motor or hydraulic system, including appropriate gearing (not shown). Injector housing 235 also preferably includes a motor controller for controlling operation of a motor and thereby controlling operation of drive member 210.

5                   Fig. 3A shows that injector housing 235 preferably comprises a retainer 205 formed with an opening 230 therein for releasable mounting syringe 10 in a predetermined position relative to injector housing 235. Opening 230 formed in retainer 205 and syringe 10 preferably comprise cooperating mounting mechanisms for securely affixing syringe 10 to injector housing 235. Preferably, such cooperating mounting mechanisms comprise  
10 cooperating retaining flanges formed upon opening 230 and mounting flanges formed upon the rearward portion of syringe 10.

In a preferred embodiment, opening 230 comprises a pair of opposed, axially extending slots 250 and 255. Slots 250 and 255 preferably separate and define a pair of radially inwardly projecting syringe retaining flanges 260 and 265 formed around the  
15 circumference of opening 230. To the rear of retaining flanges 260 and 265 is a circumferential groove or channel 270, which is in communication with the axial slots 250 and 255. Retaining flanges 260 and 265 are preferably formed as a portion of retainer 205 of injector housing 235.

Opening 230 may, for example, be machined out of aluminum or other suitable material such as plastic. Opening 230 receives and firmly secures syringe 10 to injector  
20 housing 235. In that regard, as shown in Fig. 4A, syringe 10 preferably comprises on a rear portion thereof a set of radially extending mounting flanges 160 and 165. As shown in Fig. 3E and 5, mounting flanges 160 and 165 may be of a different shape to insure a particular

alignment of syringe 10 when syringe 10 is mounted into retainer 205. In this embodiment, slots 250 and 255 are shaped so as to receive their respective mounting flanges 160 and 165. It is understood, however, that mounting flanges 160 and 165, and their respective slots 250 and 255, may be of the same shape. A radially extending drip flange 170 is preferably formed  
5 forwardly from mounting flanges 160 and 165.

Drip flange 170 assists in proper axial positioning of syringe 10 with respect to the front wall of injector housing 235 by preferably abutting the face of the front wall when syringe 10 is properly positioned. Drip flange 170 further substantially prevents liquid from leaking into injector housing 235, which may cause damage to injector 200. Drip flange 170  
10 also provides structural reinforcement for elongated cylindrical body 20.

During mounting of syringe 10 in injector housing 235, mounting flanges 160 and 165 pass through slots 250 and 255, respectively, until, for example, drip flange 170 abuts face 280 of retainer 205. When syringe 10 is mounted on the injector front wall as described above, drip flange 170 preferably makes a sealing engagement with face 280. Syringe 10 and  
15 mounting flanges 160 and 165 are then rotated from the position illustrated in Figure 3E to the position illustrated in Figure 3F such that mounting flanges 160 and 165 are rotatably and closely received in a circumferential channel 270. In this position, mounting flanges 160 and 165 abut and are retained by retaining flanges 260 and 265, respectively. The mounting procedure is simply reversed to dismount syringe 10 from injector 200.

20 Plunger extension 100 preferably comprises means for releasably attaching plunger extension 100 to drive member 210 of powered injector 200. As described above, drive member 210 cooperates with plunger extension 100 to impart substantially linear,

reciprocal motion to plunger 30. In one embodiment, as shown in Figs. 2A and 2B, plunger extension 100 preferably comprises a passage 130 through rear pressure member 120 and extending through a portion of plunger extension 100. Passage 130 preferably comprises two opposing rows of radially inwardly extending flanges or ridges 140 and intermediate  
5 grooves 145 symmetrically positioned over a range of axial positions on the sidewalls thereof. Flanges 140 and intermediate grooves 145 mate with two opposing rows of cooperating radially outwardly extending flanges or ridges 280 and intermediate grooves 285 positioned over a range of axial positions on drive member 210 to create a readily releasable attachment of plunger extension 100 and drive member 210 over a range of axial positions of the plunger 30.

10 In this embodiment, drive member 210 preferably comprises two symmetrically formed and substantially flat sides 290 and 295 (best illustrated in Figures 4D and 4E) and two curved portion therebetween on which flanges 280 and intermediate grooves 285 are formed. Passage 130 is preferably shaped in the form of an arch. In this embodiment, plunger extension 100 and drive member 210 are rotated to the relative positions illustrated in  
15 Figure 4A such that substantially flat sides 290 and 295 are aligned to face flanges 140 of passage 130. In this position, drive member 210 is substantially freely slidable in and out of passage 130. As illustrated in Figure 4B, plunger extension 100 and drive member 210 are moved in a linear manner relative to each other such that drive member 210 enters passage 130 and that flanges 140 and grooves 145 are aligned with corresponding grooves 285 and  
20 flanges 280, respectively.

Upon achieving such alignment, plunger extension 100 and drive member 210 are preferably rotated relative to each other such that a plurality of flanges 280 mate with a

plurality of grooves 145 and a plurality of flanges 140 mate with a plurality of grooves 285 to create a secure connection between drive member 210 and plunger extension 100 as illustrated in Figure 4C. In this position, drive member 210 can impart powered forward or rearward motion to plunger 30. To detach plunger extension 100 from drive member 210, plunger  
5 extension 100 and drive member 210 are rotated relative to each other such that ridges 140 face substantially flat sides 290 and 295. In this position, as set forth above, plunger extension 100 and drive member 210 are easily slidable relative to each other and may be separated.

Each of flanges 140 and cooperating flanges 280 are preferably positioned  
10 relatively close to adjacent flanges 140 and 280, respectively, to facilitated connection. There is also preferably some amount of "play" in the system to allow proper alignment of corresponding flanges and grooves upon rotatable attachment of plunger extension 100 to drive member 210. For example, plunger 30 may move forward or rearward a small amount during connective rotation to allow proper alignment. Preferably, flanges 140 and flanges 280  
15 have tapered leads to assist in assuring proper alignment.

Preferably, rotation of mounting flanges 160 and 165 of the syringe 10 to seat in circumferential channel 270 also results in attachment of plunger extension 100 and drive member 210 as described above. Thus, the plunger extension 100 and drive member 210 need not be manually aligned after installation of the syringe 10, as required by prior art  
20 syringe/injector systems. The degree of rotation required for mounting syringe 10 upon injector housing 235 and the degree of rotation required to releasably connect plunger extension 100 to drive member 210 may, for example, each be approximately 90 degrees. In



this embodiment, syringe 10 is preferably fabricated such that upon inserting plunger 30 and the attached plunger extension 100 within elongated cylindrical body 20, plunger extension 100 cannot be easily rotated relative to elongated cylindrical body 20. In this manner, elongated cylindrical body 20 and plunger extension 100 preferably can be rotated as a unit. In the  
5 embodiment illustrated in Figure 5, this result is accomplished via spines 150 on plunger extension 100 which cooperate with slots 155 on elongated cylindrical body 20 to substantially prevent relative rotation between plunger extension 100 and elongated cylindrical body 20, while permitting reciprocal axial motion of the plunger extension 100 within cylindrical body 20.

10 Likewise, the rotation of mounting flanges 160 and 165 to align flanges 160 and 165 with slots 250 and 255 to remove or dismount syringe 10 from injector housing 235 preferably results in detachable alignment of plunger extension 100 from drive member 210. In this manner, syringe 10 can be easily removed from injector housing 235.

In an alternative to the embodiment, as shown in Figure 6, the plunger  
15 extension 100' extending from the rear of plunger 30 can comprise a grooved rod similar to drive member 210 illustrated in Figures 4A through 4D. In this embodiment, the drive member 210' of the injector preferably comprises a passage 130' therethrough similar to passage 130 formed in the plunger extension 100. Each of the drive member 210' and the plunger extension 100' once again preferably comprises a plurality of cooperating attachment members (for  
20 example, circumferential flanges and intermediate grooves or channels) located over a range of axial positions thereon. The plunger extension 100' of this embodiment passes through the

passage 130' of the drive member 210' to allow releasable connection of the drive member 210' to the plunger extension 100'.

Extending the plunger extension of the present invention beyond the rear of elongated cylindrical body 20, enables operation of syringe 10 in a manual mode. That is, by application of appropriate manual force to plunger extension 100, for example, a user can draw fluid into elongated cylindrical body 20 or expel fluid from elongated cylindrical body 20. Plunger extension 100 is preferably of sufficient length that the user may take advantage of a maximum volume of elongated cylindrical body 20. Plunger extension 100 also preferably includes a flange or pressure member 120 on the rearward end thereof to facilitate manual operation.

Although the present invention has been described in detail in connection with the above examples, it is to be understood that such detail is solely for that purpose and that variations can be made by those skilled in the art without departing from the spirit of the invention except as it may be limited by the following claims.

WHAT IS CLAIMED IS:

1. A syringe for use with a powered injector, the powered injector comprising an injector housing having a powered drive member therein, the syringe comprising:

- a. an elongated body;
- b. a plunger movably mounted in the elongated body for pressurizing the fluid medium; and
- c. a plunger extension connected to the plunger and extending rearward from the plunger, the plunger extension comprising a plurality of plunger attachment members located over a range of axial positions on the plunger extension, each of the plurality of plunger attachment members adapted to form a releasable attachment with at least one corresponding injector attachment member on the powered drive member.

2. The syringe of Claim 1, further comprising a mounting mechanism connected to a rearward portion of the elongated body, the mounting mechanism comprising at least two mounting flanges adapted to rotatably and releasably mount the syringe in a desired position relative to the injector housing.

3. The syringe of Claim 1 wherein the plunger extension comprises a pressure member on the rearward end thereof adapted for manual application of force thereto.

4. The syringe of Claim 1 wherein the plurality of plunger attachment member comprise a plurality of radially extending flanges and intermediate grooves and the at least one injector attachment member comprises a radially extending flange.

5. The syringe of Claim 4 wherein the injector attachment member on the drive member comprises a plurality of radially extending flanges and intermediate groove positioned over a range of axial positions on the drive member, the plurality of flanges of the plunger extension adapted to mate with the plurality of intermediate grooves of the drive member to form a releasable connection between the drive member and the plunger extension.

6. The syringe of Claim 5 wherein the plunger extension and the drive member form a releasable connection therebetween on relative rotation thereof.

7. The syringe of Claim 6 wherein the plunger extension comprises a passage formed in the rearward end thereof through which the drive member passes when the syringe is mounted on the powered injector, the passage comprising two opposing rows of radially inwardly extending flanges and intermediate grooves, the two opposing rows of radially inwardly extending flanges adapted to cooperate and make a releasable connection with two opposing rows of radially outwardly extending flanges and intermediate grooves formed on the drive member.

8. The syringe of Claim 6 wherein the drive member comprises a passage formed in the forward end thereof through which the plunger extension passes when the syringe is mounted on the powered injector, the passages comprising two opposing rows of radially inwardly extending flanges and intermediate grooves, the two

opposing rows of radially inwardly extending flanges adapted to cooperate and make a releasable connection with two opposing rows of radially outwardly extending flanges and intermediate grooves formed on the passage of the plunger extension.

9. The syringe of Claim 7 wherein the relative rotation of the plunger extension and the drive member to make the releasable connection therebetween corresponds to a rotation necessary to releasably mount the syringe to the powered injector.

10. The syringe of Claim 9 wherein the plunger extension comprises at least one abutment member for substantially preventing rotation of the plunger extension relative to the elongated cylindrical body of the syringe.

11. A syringe for use with a powered injector, the powered injector comprising an injector housing having a powered drive member therein, the syringe comprising:

- a. an elongated body;
- b. a plunger movably mounted in the elongated body for pressurizing the fluid medium;
- c. a plunger extension connected to the plunger and extending rearward from the plunger, the plunger extension comprising at least one plunger attachment member thereon, the at least one plunger attachment members adapted to form a releasable attachment with each of a plurality of injector attachment members located over a range of axial positions on the drive member.

12. The syringe of Claim 11, further comprising a mounting mechanism connected to a rearward portion of the elongated body, the mounting mechanism comprising at least two mounting flanges adapted to rotatably and releasably mount the syringe in a desired position relative to the injector housing.

13. The syringe of Claim 1 wherein the plunger extension comprises a pressure member on the rearward end thereof adapted for manual application of force thereto.

14. The syringe of Claim 11 wherein the plurality of injector attachment member comprise a plurality of radially extending flanges and intermediate grooves and the at least one plunger attachment member comprises a radially extending flange.

15. The syringe of Claim 15 wherein the plunger extension and the drive member form a releasable connection therebetween on relative rotation thereof.

16. The syringe of Claim 15 wherein the relative rotation of the plunger extension and the drive member to make the releasable connection therebetween corresponds to a rotation necessary to releasably mount the syringe to the powered injector.

17. The syringe of Claim 16 wherein the plunger extension comprises at least one abutment member for substantially preventing rotation of the plunger extension relative to the elongated cylindrical body of the syringe.

18. A powered injector for use with a syringe, the syringe comprising a plunger, the plunger comprising a plunger extension connected to the plunger and extending rearward from the plunger, the plunger extension comprising a plurality of

plunger attachment members located over a range of axial positions on the plunger extension, the powered injector comprising:

- a. an injector housing;
- b. a retainer for releasably mounting the syringe at a desired position relative to the injector housing; and
- c. a drive member disposed within the injector housing, the drive member comprising a plurality of injector attachment members located over a range of axial positions on the powered drive member;

the plurality injector attachment members adapted to mate with the plurality of plunger attachment members to form a releasable connection between the drive member and the plunger extension such that at one axial position of the drive member, the plunger extension can be connected to the drive member over a range of axial positions of the plunger extension.

19. An injector system comprising a powered injector and a syringe, the powered injector comprising:

- a. an injector housing;
- b. a retainer for releasably mounting a syringe at a desired position relative to the injector housing; and
- c. a drive member disposed within the injector housing, the drive member comprising a plurality of injector attachment members

located over a range of axial positions on the powered drive member;

the syringe comprising:

- d. an elongated body;
- e. a plunger movably mounted in the elongated body for pressurizing the fluid medium; and
- f. a plunger extension connected to the plunger and extending rearward from the plunger, the plunger extension comprising a plurality of plunger attachment members located over a range of axial positions on the plunger extension;

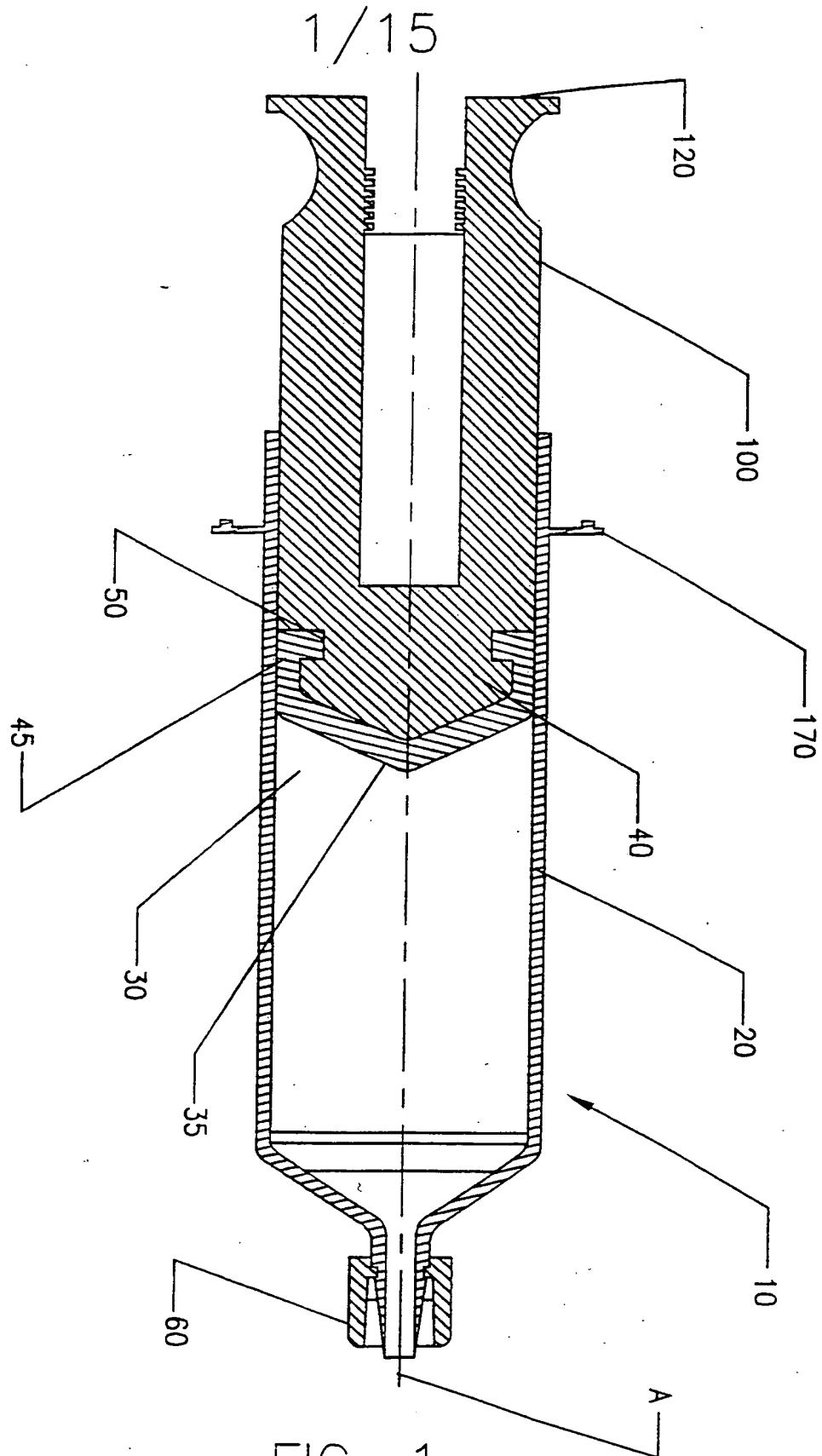
the plurality of plunger attachment members adapted to mate with the plurality injector attachment members to form a releasable connection between the drive member and the plunger extension such that at one axial position of the drive member, the plunger extension can be connected to the drive member over a range of axial positions of the plunger extension.

20. A plunger for use in a syringe for use with a powered injector, the injector comprising a powered drive member, the plunger being adapted to be movably mounted in the syringe for pressurizing the fluid medium, the plunger comprising a plunger extension connected to the plunger and extending rearward from the plunger, the plunger extension comprising a plurality of plunger attachment members located over a range of axial positions on the plunger extension, each of the plurality of plunger



attachment members adapted to form a releasable attachment with at least one corresponding injector attachment member on the powered drive member.

21. A drive member for use in a powered injector for use with a syringe, the syringe comprising a plunger movably mounted in the syringe for pressurizing the fluid medium, the plunger comprising a plunger extension connected to the plunger and extending rearward from the plunger, the drive member comprising a plurality of injector attachment members located over a range of axial positions on the drive member, each of the plurality of injector attachment members adapted to form a releasable attachment with at least one corresponding plunger attachment member on the plunger extension.



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FIG. 2A

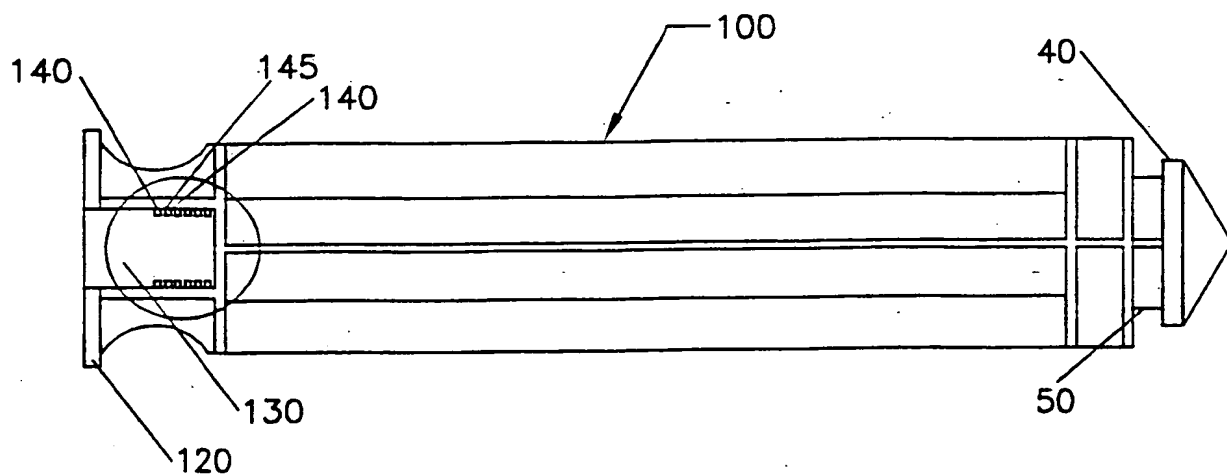
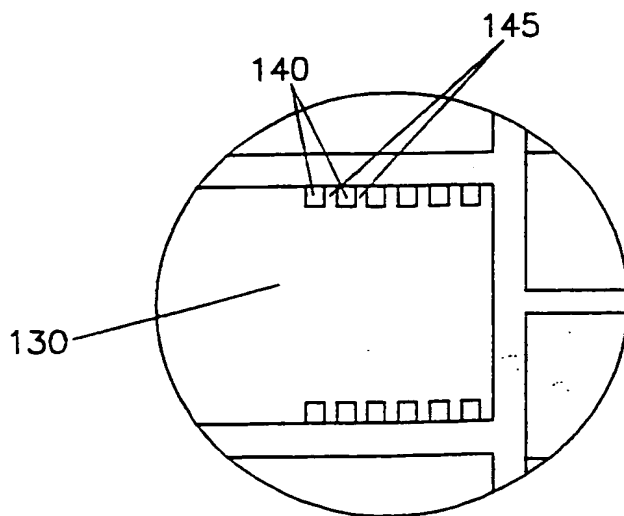


FIG. 2B



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FIG. 2C

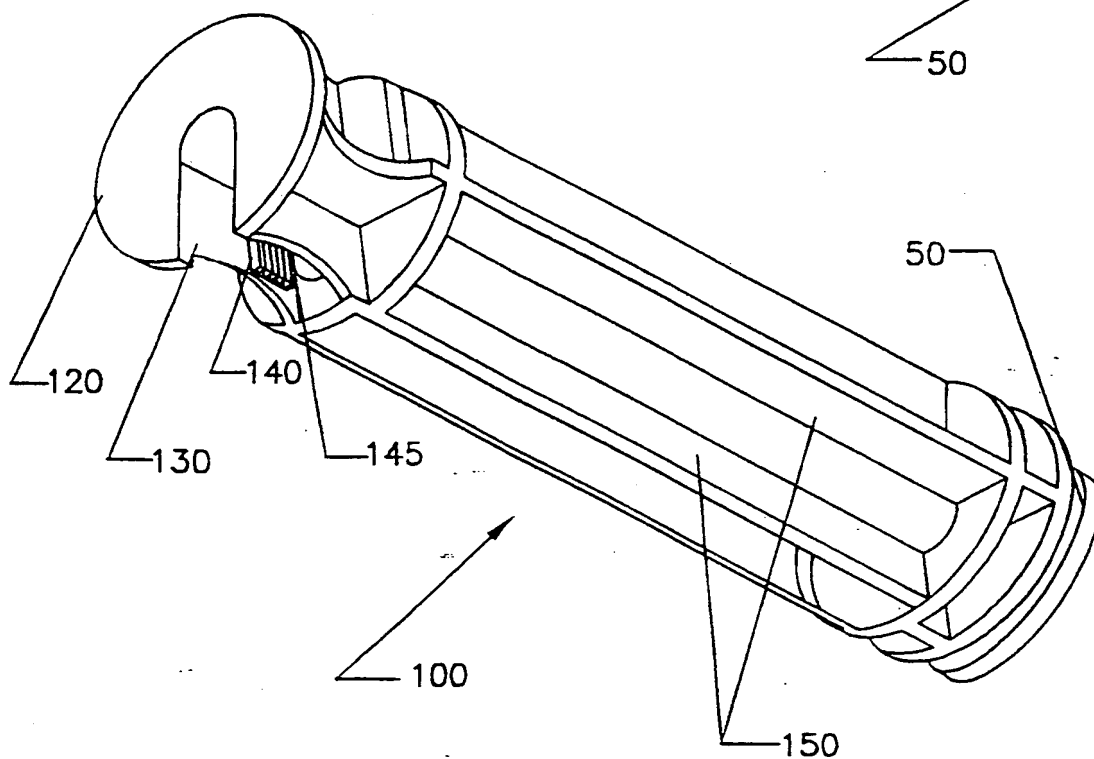
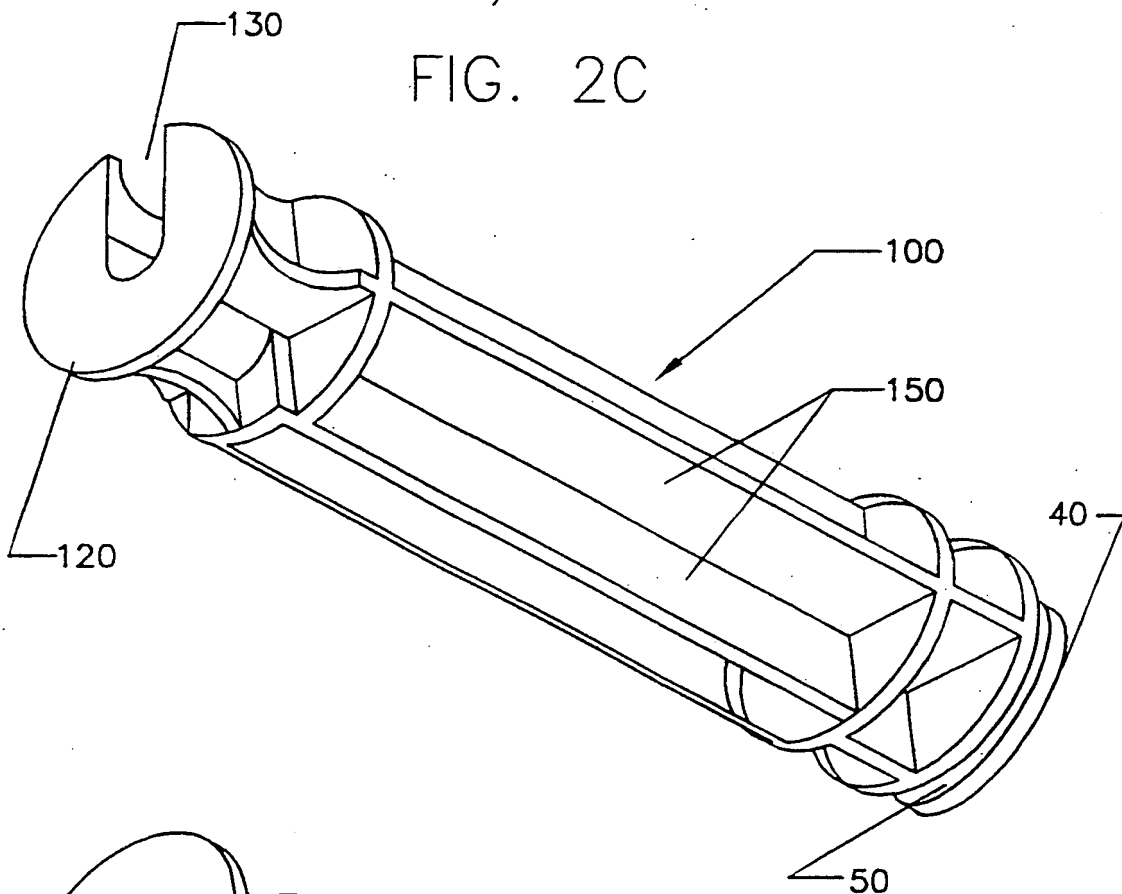


FIG. 2D

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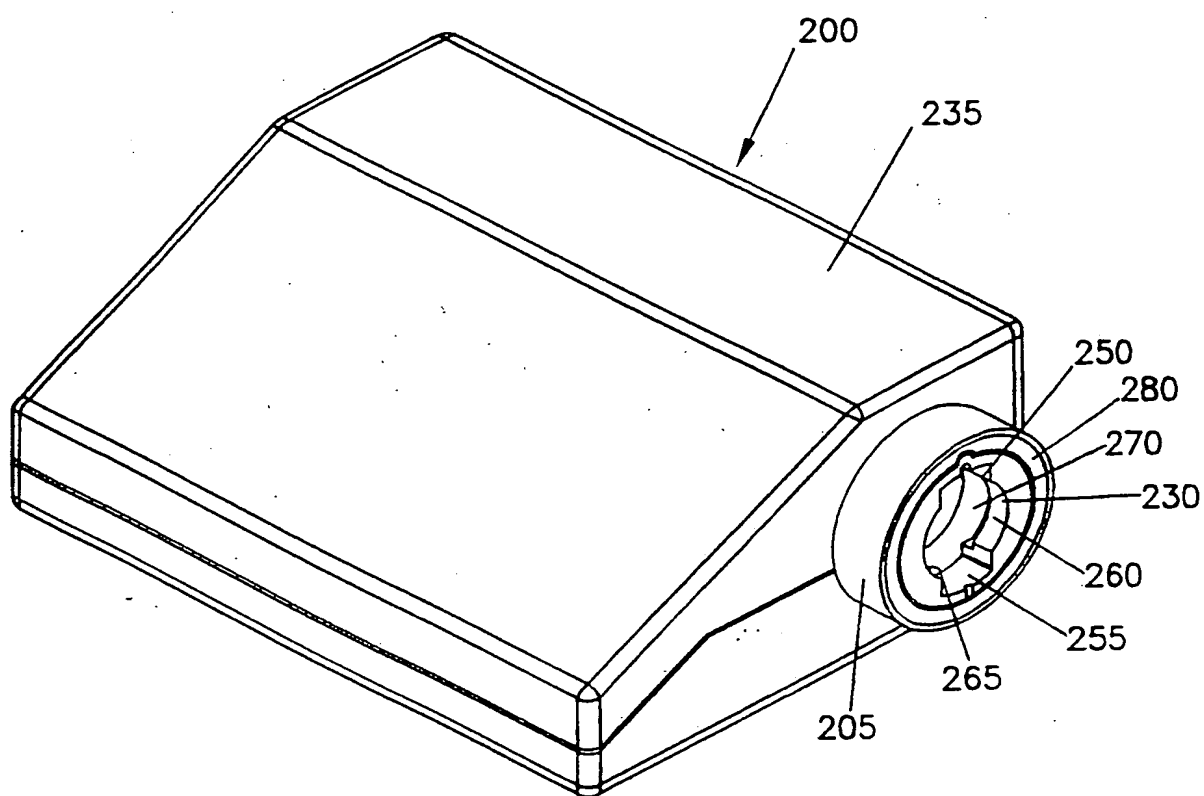


FIG. 3A

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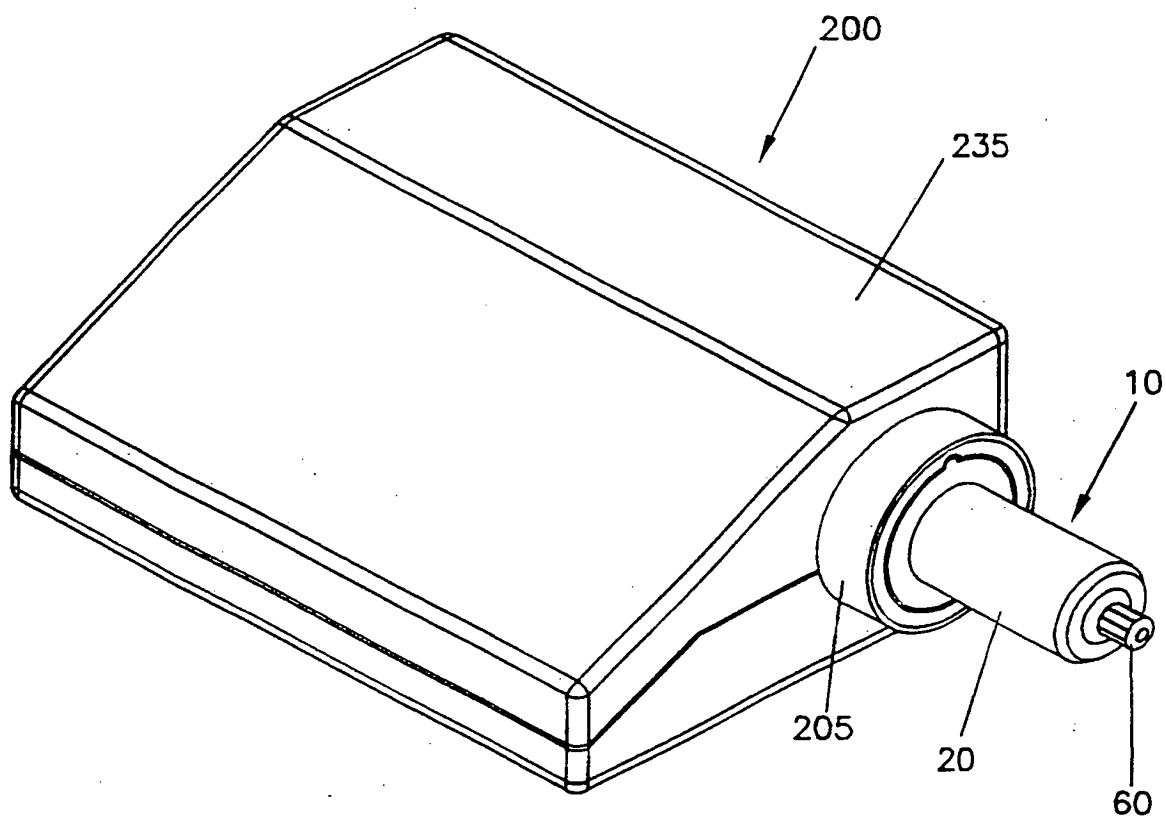


FIG. 3B

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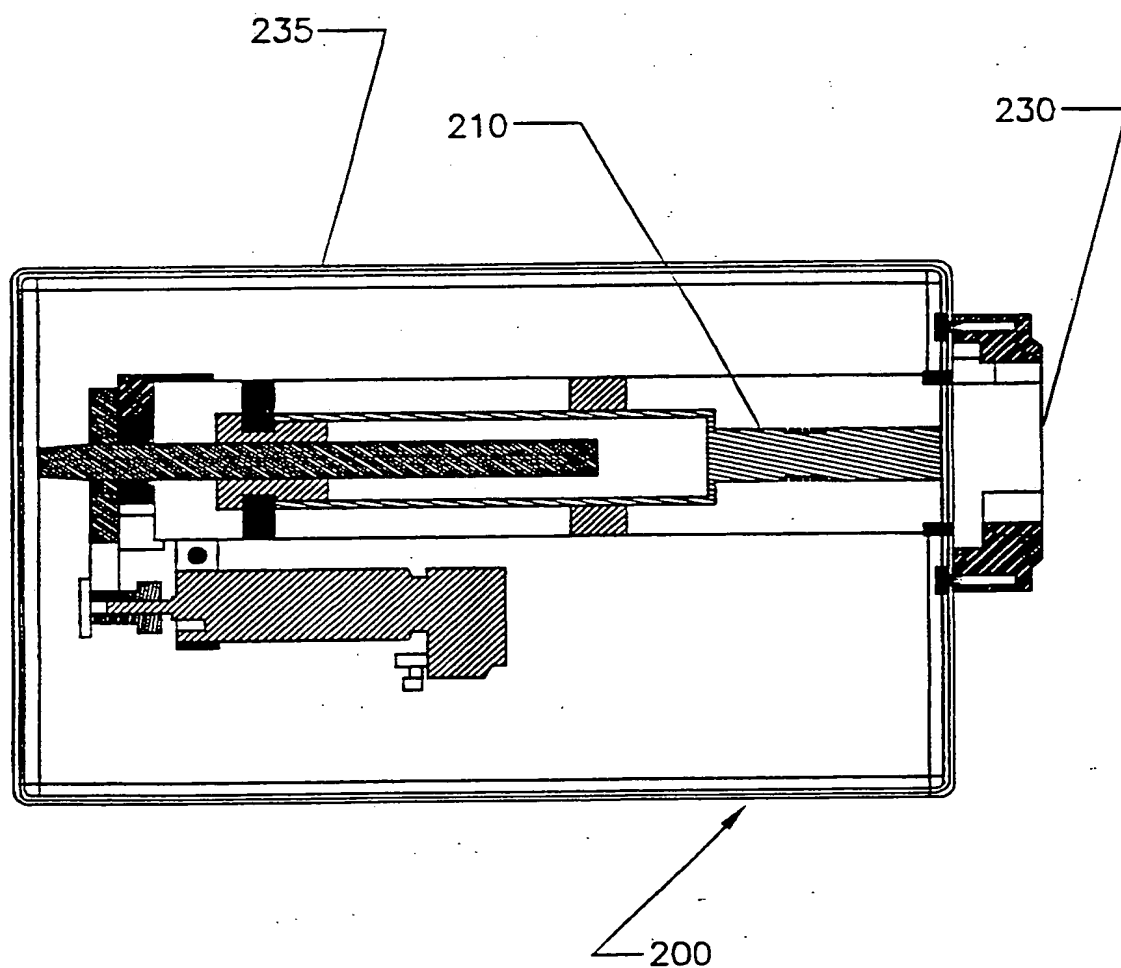


FIG. 3C

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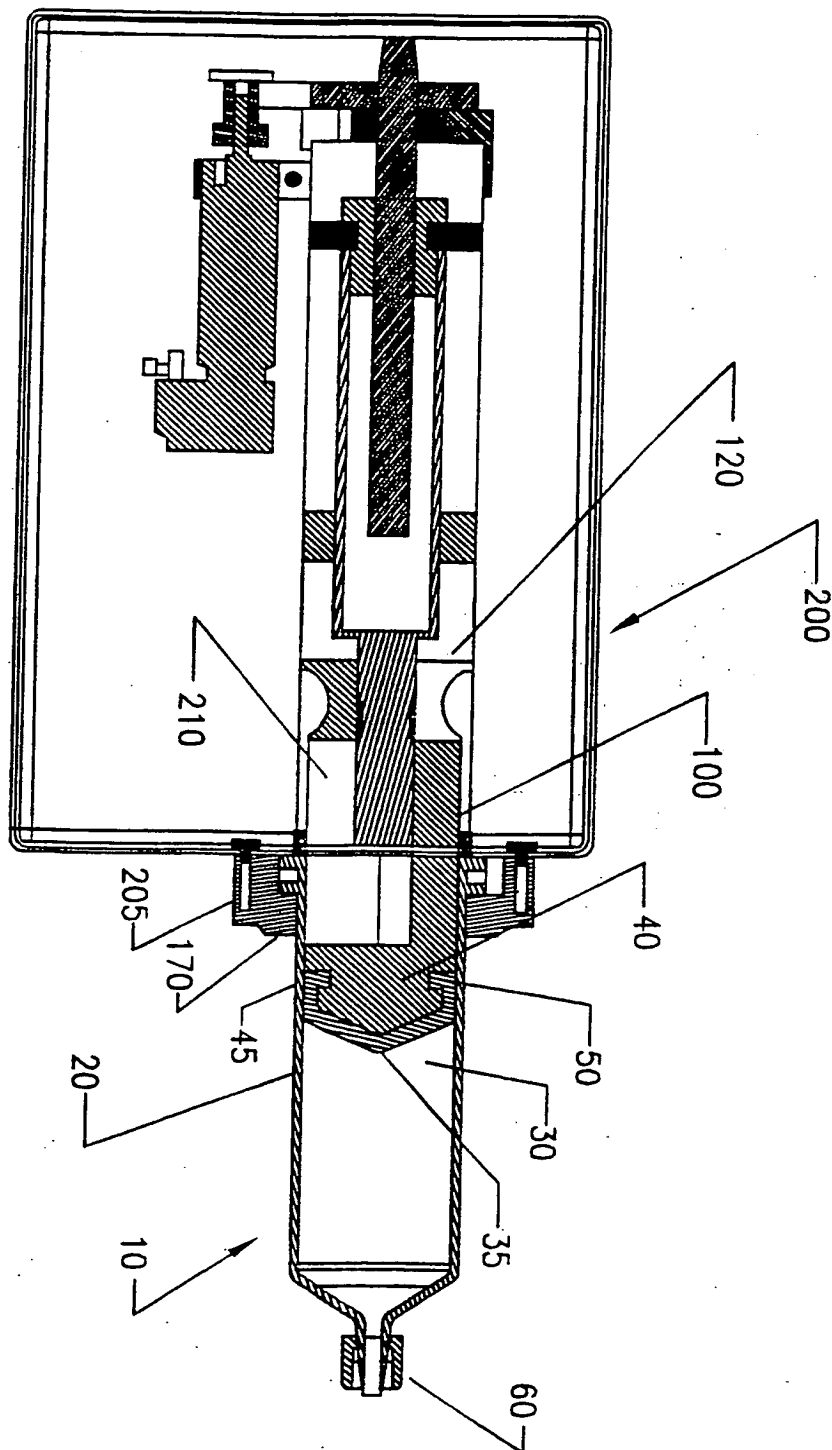


FIG. 3D



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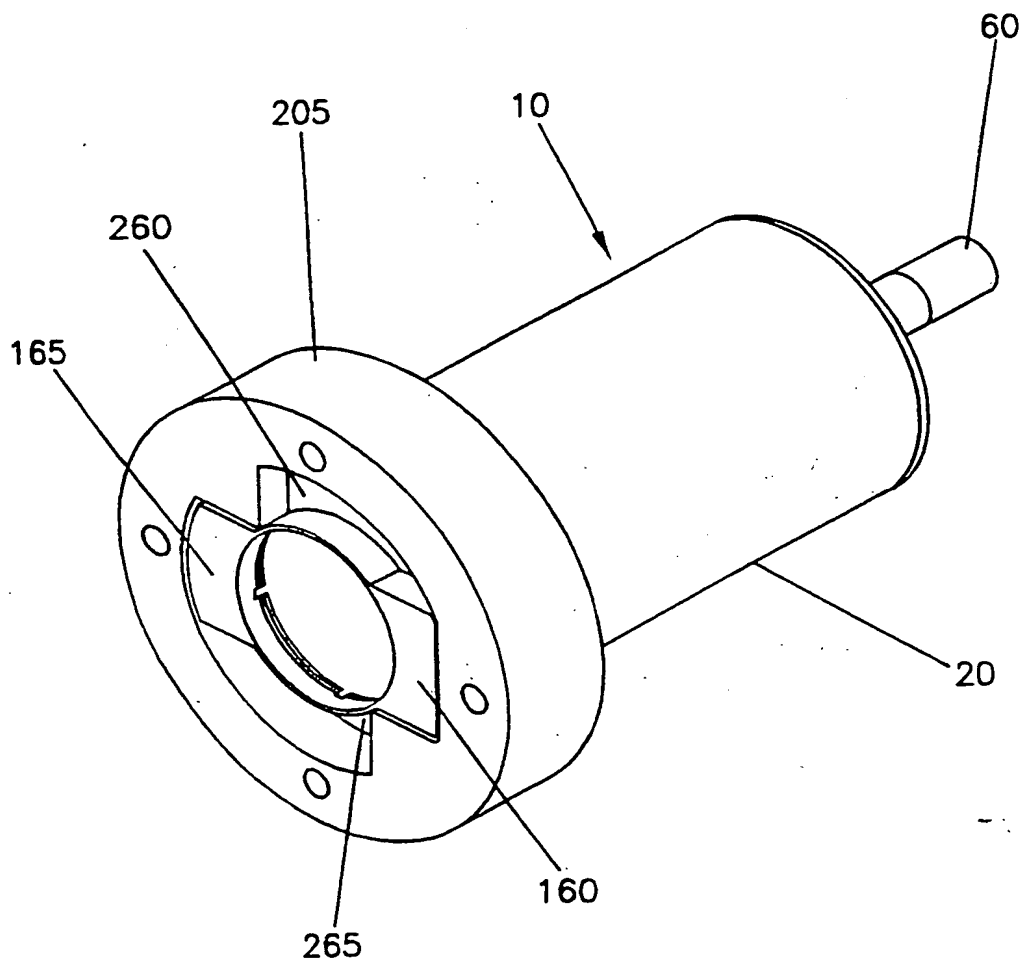


FIG. 3E

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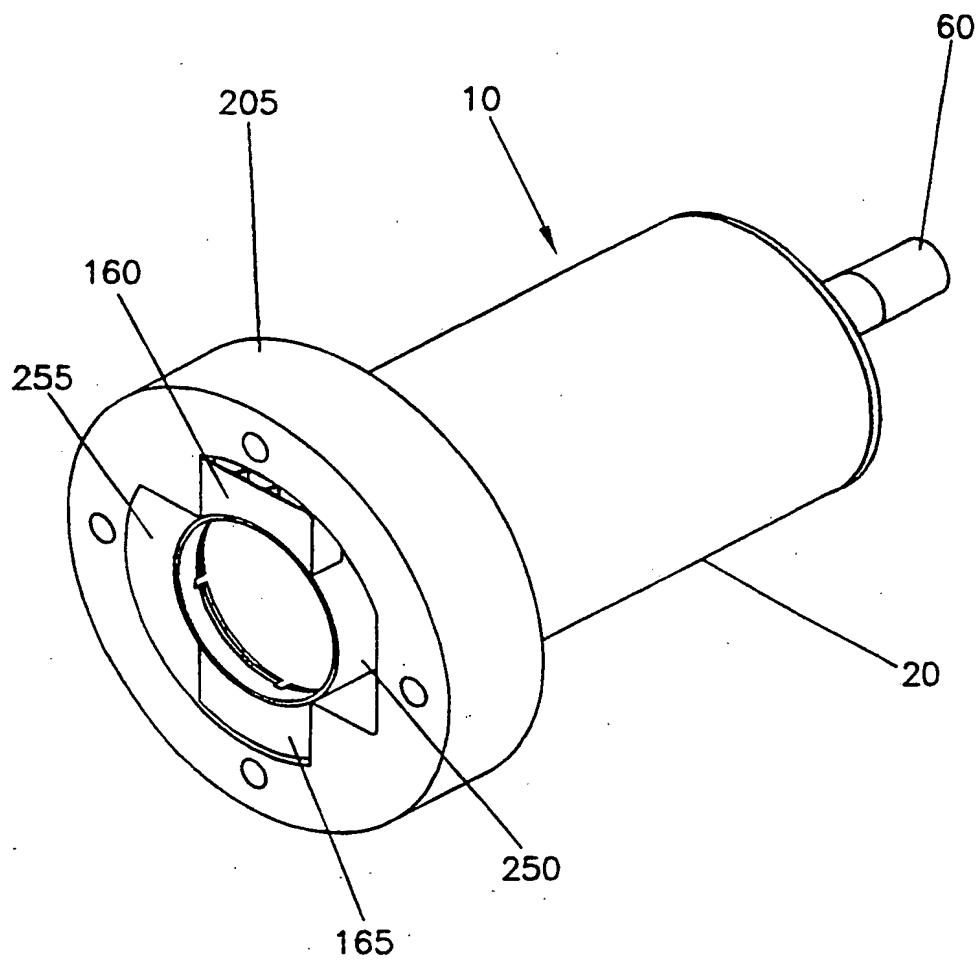


FIG. 3F

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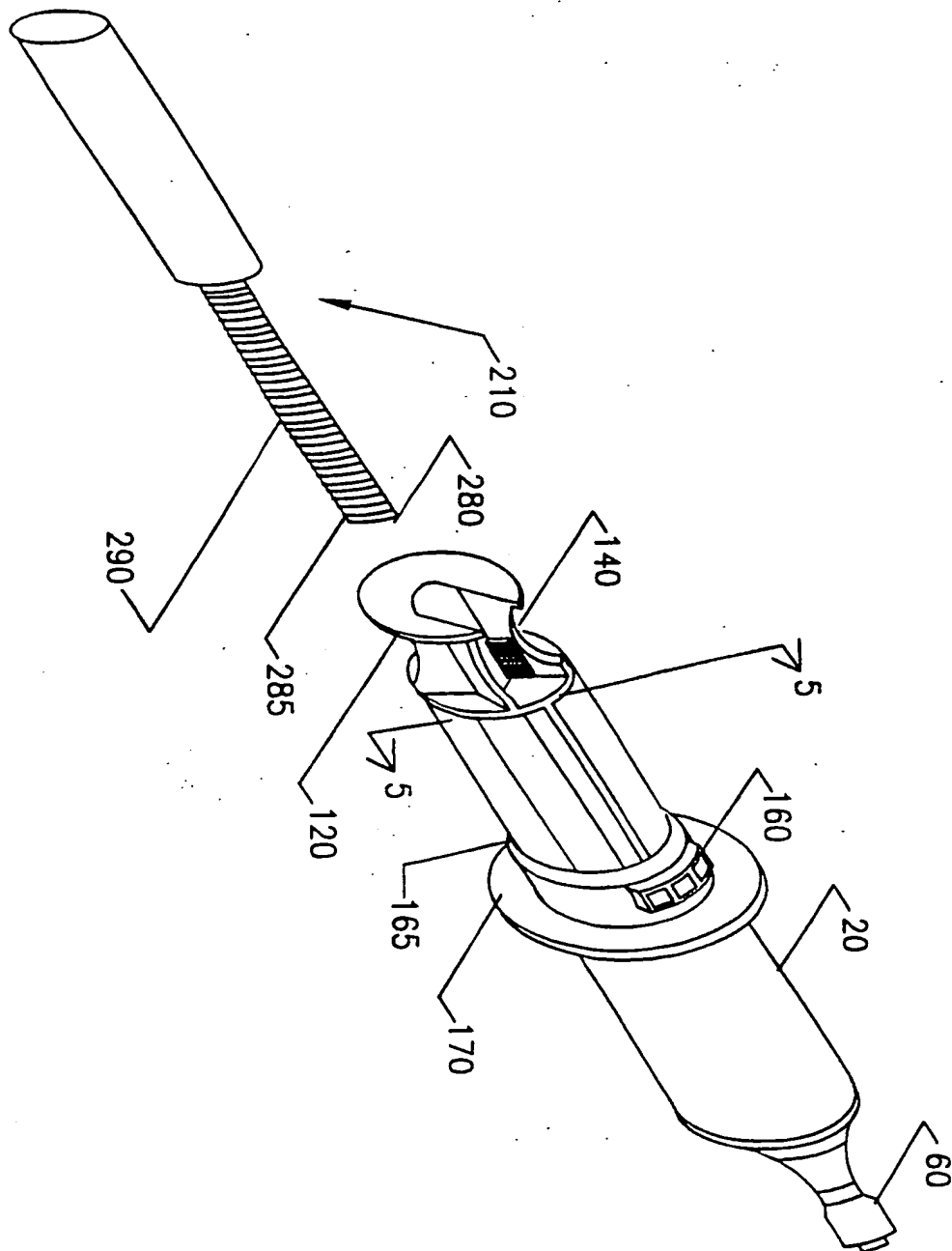


FIG. 4A

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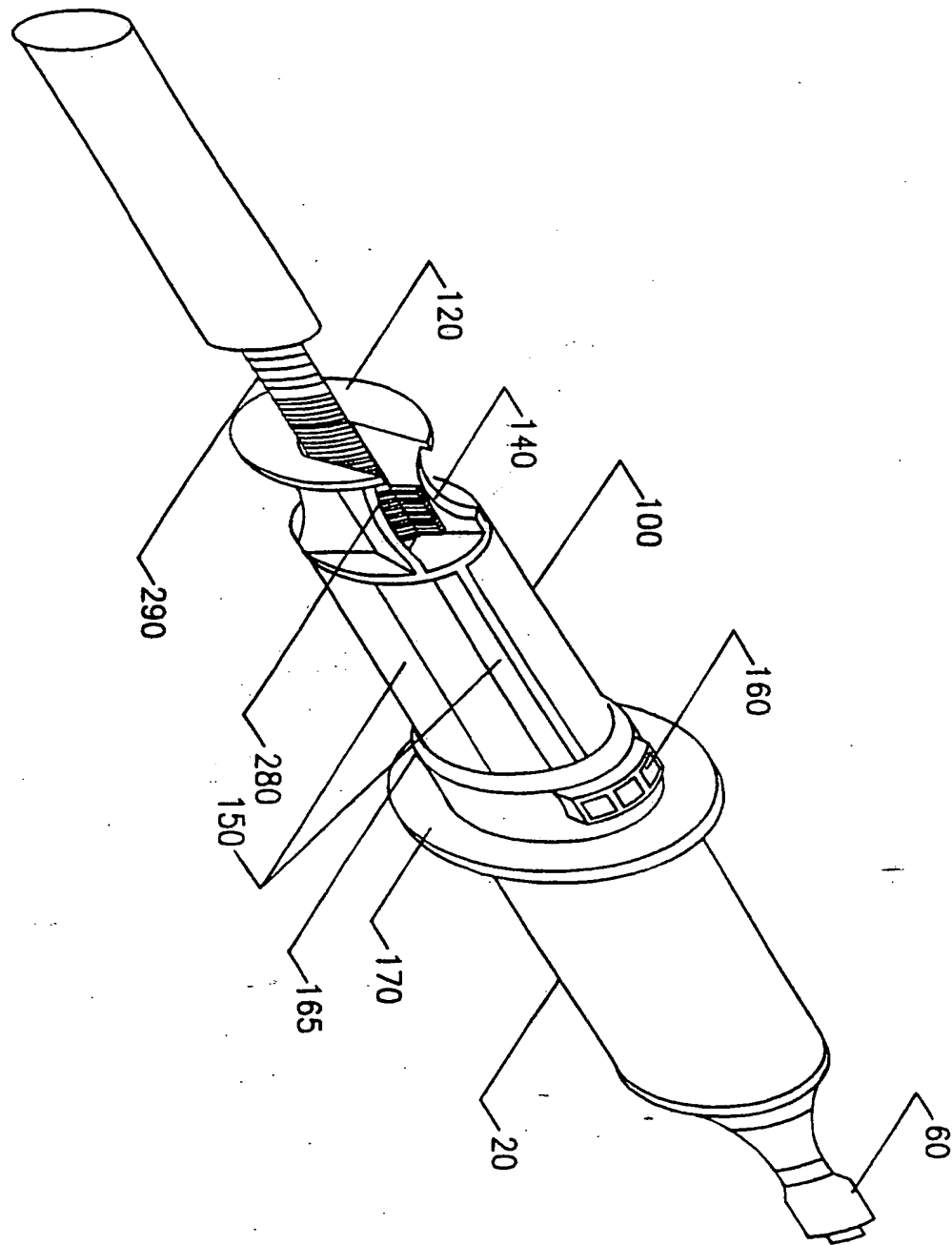


FIG. 4B

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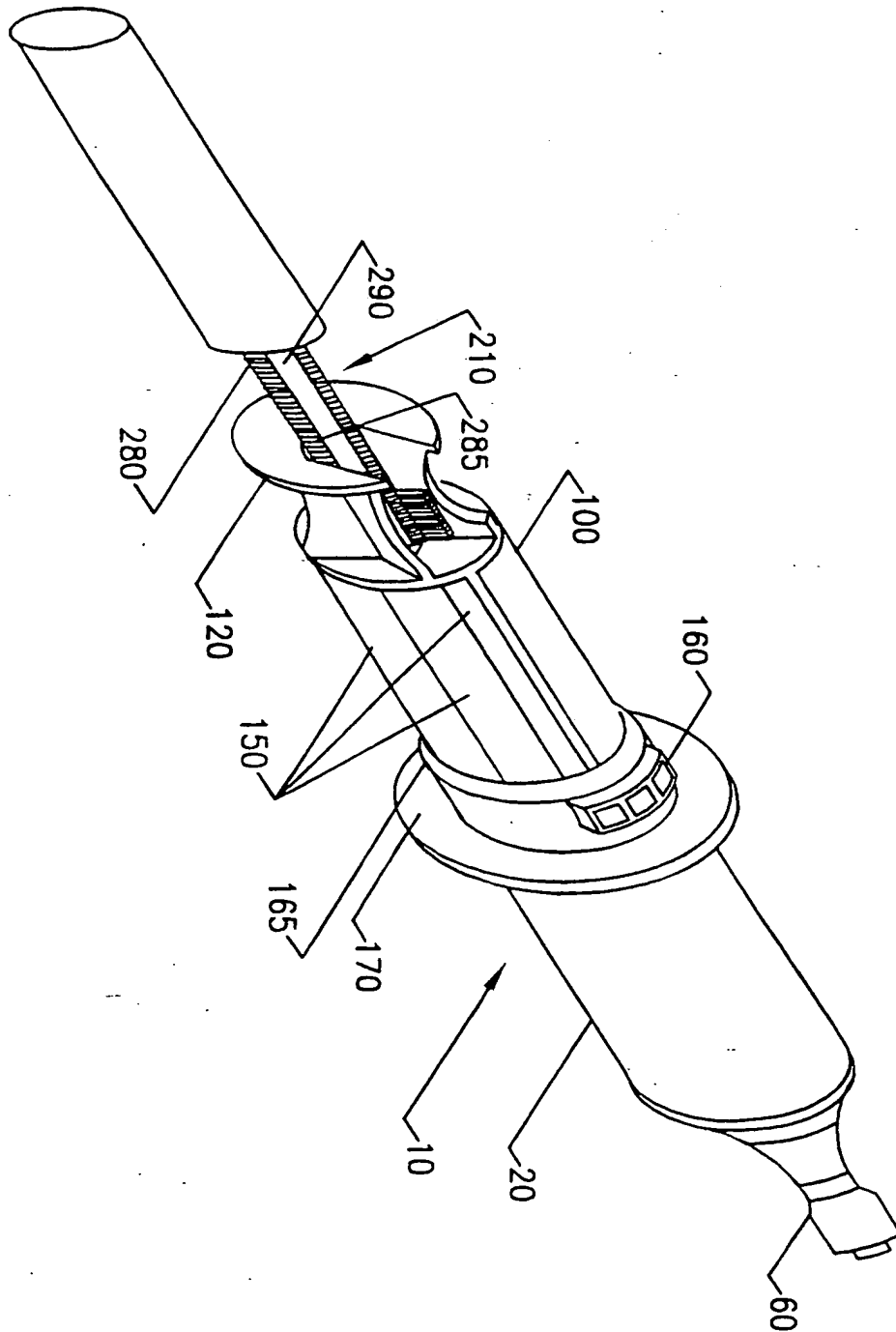


FIG. 4C

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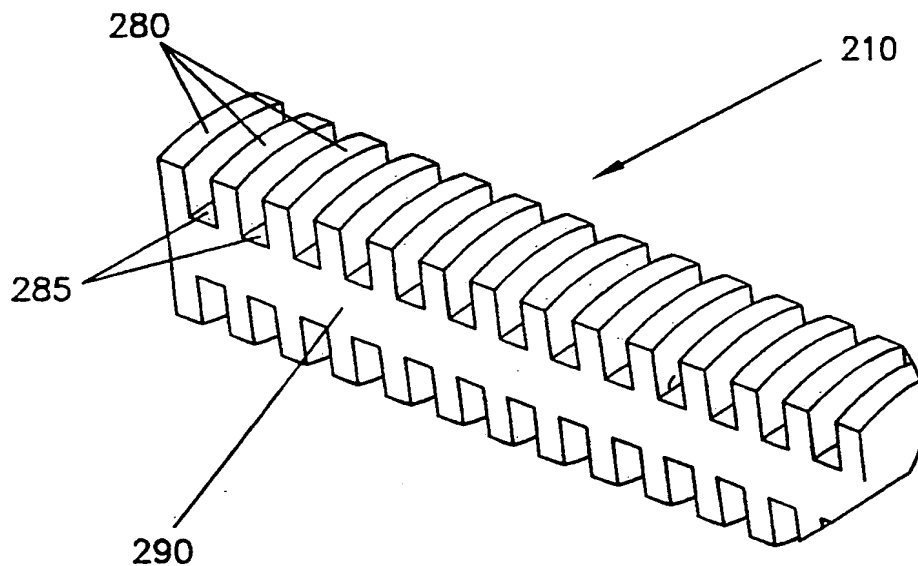


FIG. 4D

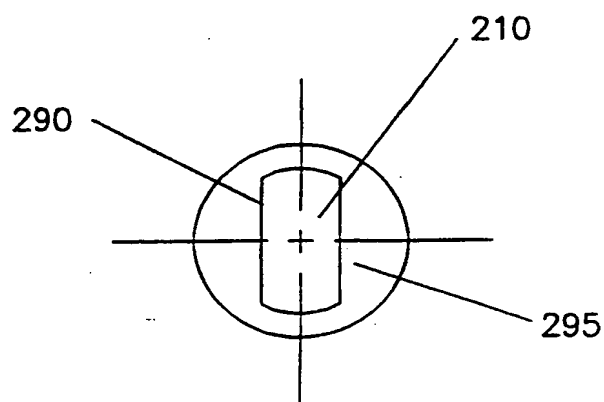


FIG. 4E

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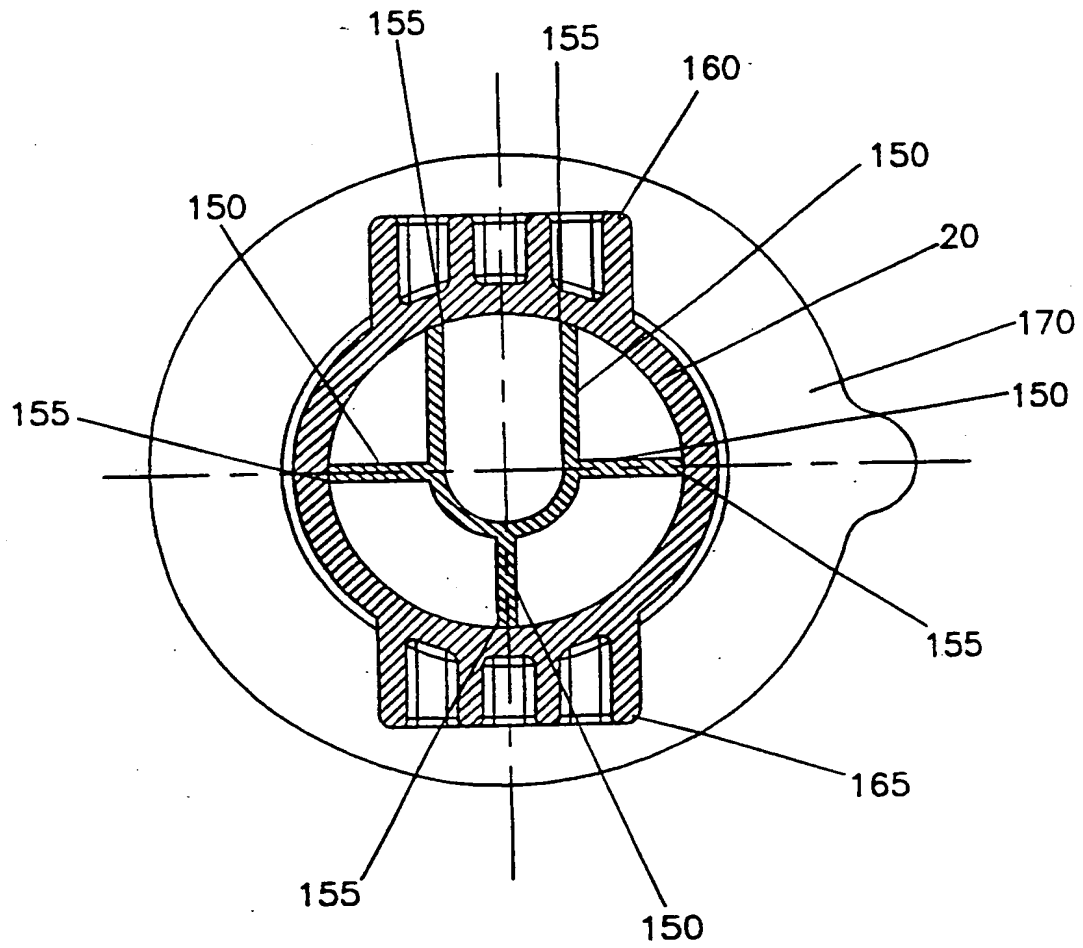


FIG. 5

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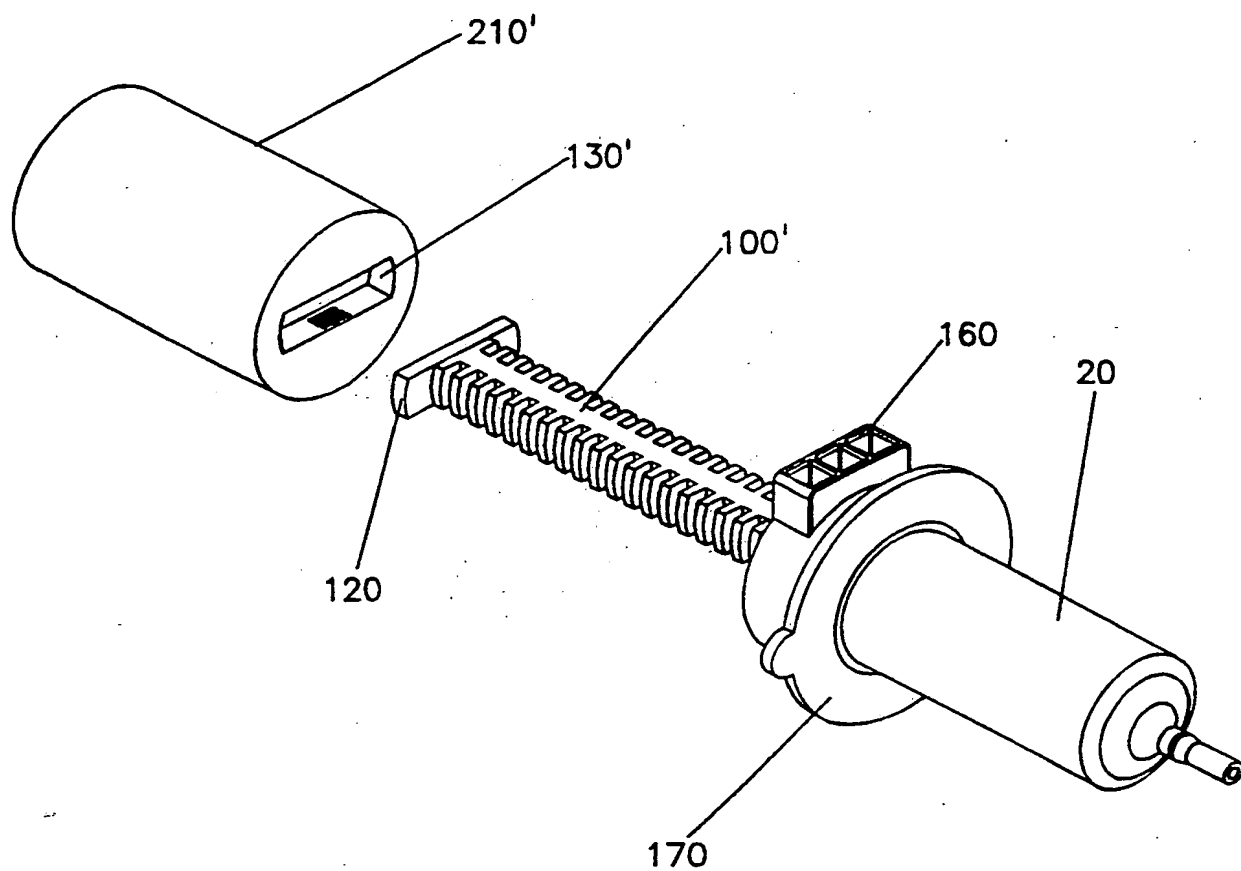


FIG. 6



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 97/17840

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 A61M5/145

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A61M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No. |
|------------|--|-----------------------|
| X          | EP 0 064 858 A (MERCK & CO) 17 November 1982<br>see page 5, line 6 - line 8; figure<br>---   | 1-6,<br>11-16,20      |
| X          | EP 0 204 977 A (INTELLIGENT MEDECINE INC) 17 December 1986<br>see page 7, line 8 - page 9, line 16; figures<br>---                         | 1-6,<br>11-21         |
| X          | US 3 702 608 A (TIBBS) 14 November 1972<br>see the whole document<br>---   | 18,21                 |
| A          | EP 0 584 531 A (MEDRAD INC) 2 March 1994<br>cited in the application<br>see the whole document<br>& US 5 383 858 A (REILLY ET AL)<br>----- | 1-21                  |

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search

9 February 1998

Date of mailing of the international search report

17/02/1998

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Clarkson, P

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 97/17840

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                                    | Publication<br>date                          |
|---|---------------------|---|--|
| EP 64858 A                                | 17-11-82            | AR 228395 A<br>BR 8202508 A                                   | 28-02-83<br>12-04-83                         |
| EP 204977 A                               | 17-12-86            | CA 1278481 A<br>JP 61280868 A<br>US 4908017 A<br>US 4846797 A | 02-01-91<br>11-12-86<br>13-03-90<br>11-07-89 |
| US 3702608 A                              | 14-11-72            | NONE  |  |
| EP 584531 A                               | 02-03-94            | US 5383858 A<br>CA 2097848 A<br>JP 2544571 B<br>JP 6154322 A  | 24-01-95<br>18-02-94<br>16-10-96<br>03-06-94 |